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Delineation of Gypsum Mined Soils using Remote Sensing Techniques

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ABSTRACT. *A study was carried out in an area of 20,368 hectares in the gypsiferous black soils distributed in parts of Coimbatore district, Tamil Nadu State, India with the objective of identification and delineation of gypsum mined soils for their characterisation and rehabilitation using remote sensing tools.*

Satellite data (SPOT 1 HRV - 2 MLA FCC 1:50,000 scale) were interpreted visually, based on image characteristics in conjunction with Survey of India Toposheets (58 F/1, 58 F/2 and 58 F/5). Five physiographic units, viz., upland with gentle slope and low intense cultivation (U_1), upland with very gentle and medium intense cultivation (U_2), upland with very gentle slope and prosopis vegetation (U_3) and lowland with very gentle slope and high intense cultivation (L) were recognized. Sample strips encompassing all the physiographic units were studied in detail for the soil and land use composition.

It was observed that lands falling under unit U_3 and U_4 (554 ha; 2.72%) have been mined for gypsum. Lands belonging to unit U_1 (7307 ha; 35.87%) are subjected to mining during the study period and lands of U_2 and L (12507 ha; 61.41%) units are unmined. This investigation revealed the potential use of remote sensing techniques for identifying and delineation of mined soils for their characterisation and rehabilitation.

INTRODUCTION

Advancement in space technology opened up possibilities of remote sensing application in soil mapping. Recent advances in remote sensing technology have opened new vistas in the mapping and monitoring of natural resources like salt affected and degraded lands in India (Teotia *et al.*, 1980; Sharma *et al.*, 1986). At global level, about 1965 million hectares of land have been affected by soil degradation, of which 25 million hectare were affected by industrial activity (Oldeman *et al.*, 1991). In India there are about 5000 mining

leases for different minerals like coal, iron, manganese, copper, gold, rock phosphate and lime stone which covers about 0.7 million ha. Mined lands are associated with wide range of problems *viz.*, depletion of floral and faunal populations, loss of fertile top soil, sliding and erosion, pollution of air and water (Soni *et al.*, 1991). Mining of minerals like iron, coal, lime stone, gypsum are in vogue in Tamil Nadu, but the aerial extent of these lands have not been reported yet. The present study was planned with a view to identify and delineate the gypsum mined soils using remote sensing technology.

The study area covers 20,368 hectares of the gypsiferous black soil *viz.*, Dasarapatti series (Thiyagarajan, 1988) and distributed in parts of Coimbatore district, Tamil Nadu State, India. It lies between 10°31' and 11°00'N latitude and 77°05' and 77°18'E longitude. The mean annual precipitation is about 690 mm. The soil temperature and soil moisture regimes of the study area according to soil taxonomy (Soil Survey Staff, 1992) were isohyperthermic and ustic, respectively.

MATERIALS AND METHODS

SPOT data with high ground resolution of 20 x 20 m were employed in the present investigation. Two types of False Colour Composite (FCC) were used. One of the two products was Geocoded FCC print on 1 : 50,000 scale (MLA 216 328; date of pass : 26.5.88) and it was interpreted with the aid of light table. The second product was Geocoded FCC diapositive on 1 : 250,000 scale (MLA 216 329; date of pass : 26.5.88) and this was enlarged to 1 : 50,000 scale by using large format optical enlarger and then interpreted. Survey of India Toposheets (58 F/1, 58 F/2 and 58 F/5) of 1 : 50,000 scale were used for reference purpose.

An overlay of the base map of the study area prepared from the Survey of India toposheets, 58 F/1, 58 F/2 and 58 F/5, on 1 : 50,000 scale was super imposed over the satellite imageries. Visual Interpretation was carried out with image interpretation elements such as tone, texture, size, pattern and association. The prefield map was prepared by identifying and delineating different image interpretation units (areas having similar image interpretation elements) on the overlay of the base map of the study area. Field visit was undertaken with the prefield map to find out the physiography of each image interpretation unit and its soil and land use composition. Five physiographic units, *viz.*, upland with very gentle slope and low intense cultivation (U_1), upland with very gentle slope and medium intense cultivation (U_2), upland with

very gentle slope and prosopis vegetation (U_3), upland with very gentle slope and uncultivated (U_4) and lowland with high intensive cultivation (L) were identified. After the completion of field visit, a final map showing the physiography, soil and land use composition was prepared from the prefield map. The area of each physiographic unit was calculated using a planimeter and a grid sheet.

RESULTS AND DISCUSSION

Physiographic units and their description

Different physiographic units delineated during prefield interpretation based on imagery interpretation elements were identified during field visit. The image interpretation elements which were useful for the identification of the physiographic units are presented in Table 1.

Table 1. Image interpretation keys of physiographic units.

Physiographic unit	Tone	Texture	Size	Pattern	Location/ Association
U_1	Dark blue	Medium	Varying	Scattered	Associated with uplands
U_2	Dark blue with red mottles	Medium to fine	Varying	Scattered	Associated with irrigation channels
U_3	Dull red with blue mottles	Medium	Varying	Contiguous	Association with uplands
U_4	Light blue to white	Medium	Varying	Scattered	Associated with uplands
L	Red	Fine	Varying	Contiguous	Associated with tanks and canals

The description of the physiographic units is given below:

Upland with gentle slope and low intense cultivation (U_1)

The unit comprises of uplands with 1-3 percent slope, the elevations ranging from 383 to 423 m above MSL. This unit is conspicuous on the SPOT data by its dark blue tone and medium to fine texture. This is due to low intensity (dry land) cultivation in this area and the lands are unmined.

Upland with very gentle slope and medium intense cultivation (U_2)

This unit includes uplands with 1-3 percent slope and elevations ranging from 357 to 410 M above MSL. The lands are mostly associated with irrigation channels. This physiographic unit is depicted by dark bluish tone with red mottles. This is because of the medium intensity (garden land) cultivation.

Upland with very gentle slope and *Prosopis* vegetation (U_3)

This unit consists of uplands with 1-3 percent slope and the elevation ranging from 348-423 m above MSL. The soils are mostly uncultivated and subjected to uncontrolled erosion after gypsum quarrying thereby resulting in the formation of bad land topography. This unit can be identified by dull reddish tone with blue mottles. This is due to the profuse growth of *Prosopis juliflora*. This unit is associated with uplands with low intense cultivation (U_1).

Upland with very gentle slope and uncultivated (U_4)

This unit comprises of uplands with 1-3 percent slope and elevation ranging from 348 to 404 m above MSL and is associated with upland with gentle slope. This unit also presents a bad land topography like U_3 but no natural vegetation was present at the time of field investigation. The lands are left uncultivated and hence display light blue to white tone in the satellite imagery.

Lowland with high intense cultivation (L)

This unit includes low land with 0-1 percent slope and the elevation ranging from 357 to 375 m above MSL. This unit is associated with tanks and canals. Wetland cultivation is dominant in this area. It is differentiated from other physiographic units by the reddish tone associated with water bodies.

Table 2. Soil and land use composition in physiographis units.

Physiography	Mapping unit	Soil	Land use	Area	
				(ha)	(%)
Upland with very gentle slope and low intense cultivation	U1	Unmined soil	Sorghum sunflower bengal gram wheat	7307	35.87
Upland with very gentle slope and medium intense cultivation	U2	Unmined soil	Cotton tobacco maize paddy	9392	46.12
Upland with very gentle slope and prosopis vegetation	U3	Mined soil	Prosopis	324	1.59
Upland with very gentle slope and uncultivated	U4	Mined soil	Uncultivated	230	1.13
Lowland with high intense cultivation	L	Unmined soil	Paddy sugarcane	3115	15.29

Land use

A relationship was established between the physiographic units and soil and land use composition (Table 2). The mapping units U_1, U_2 and L are unmined soils where agricultural activity is carried out in different intensities. The mapping unit U_1 is cultivated with low intensity and crops like sorghum, sunflower, bengal gram and wheat are raised under dryland conditions. Cultivation is medium intense in U_2 and crops like cotton, tobacco, maize and paddy are cultivated under gardenland conditions. Intense cultivation with paddy and sugarcane was observed in the lowlands (L). The mapping

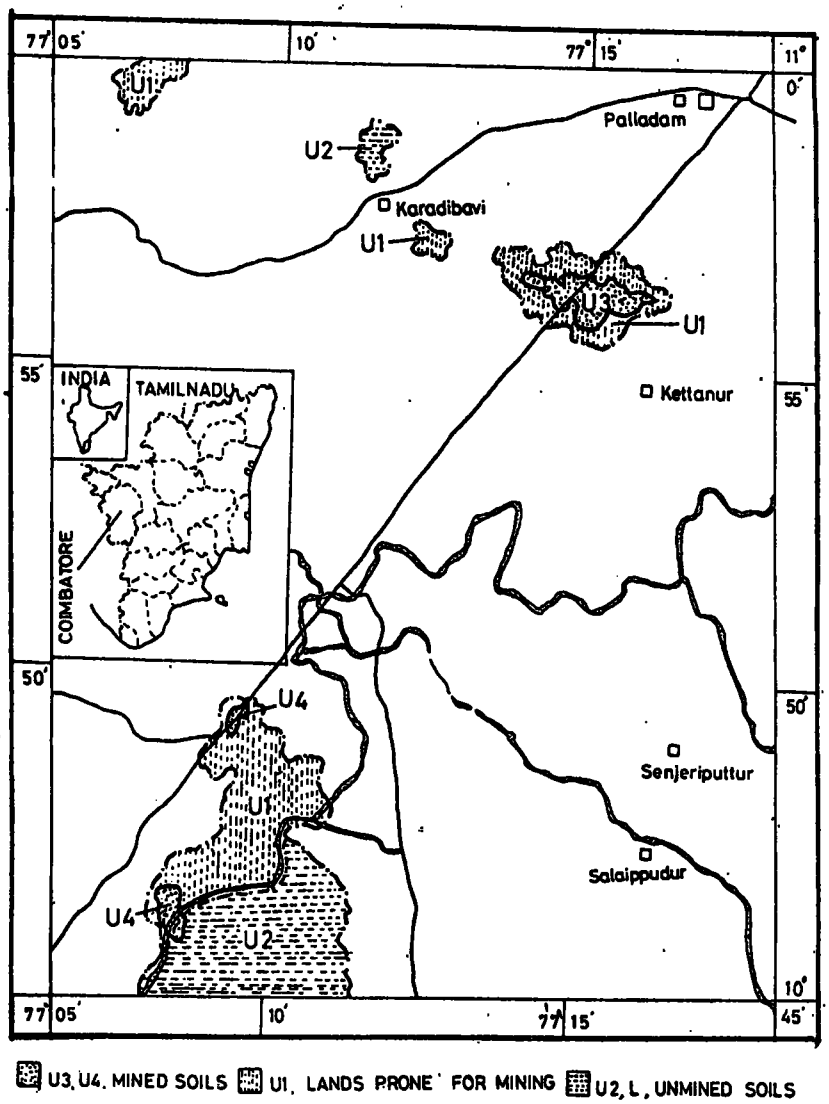

Figure 1. **Distribution of mined and unmined soils, scale 1: 250,000.**

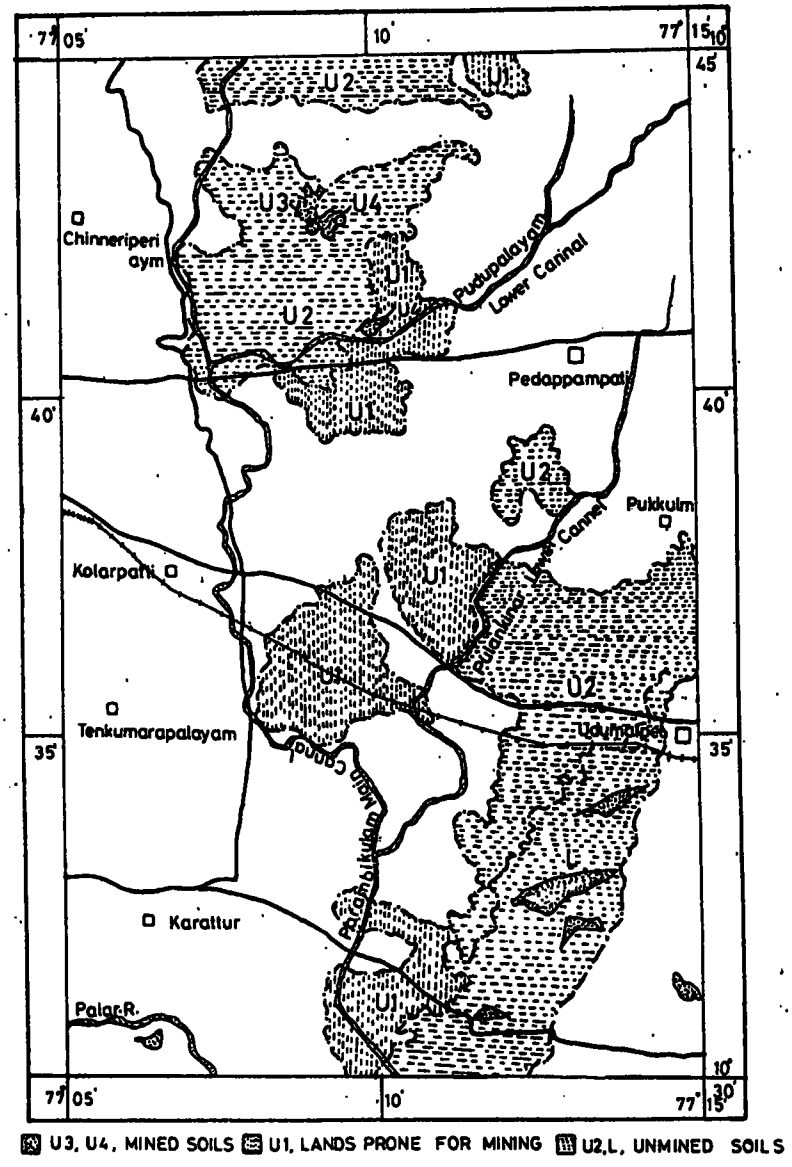

Figure 2. **Distribution of mined and unmined soils, scale 1: 250,000.**

units U_3 and U_4 belong to the mined soils, the former is vegetated with *Prosopis* and latter one is non-vegetated. Similar kind of physiographic analysis for soil and land use composition was reported by Ghosh and Ghosh (1990) and Chatterjee *et al.* (1990).

Extent of mined soils

The extent of physiographic units and the gypsum mined soils was arrived from the past field map on 1 : 50,000 scale. Figure 1and 2 depict the distribution of gypsum mined and unmined soils at 1 : 50,000 scale. Out of the total area of 20368 hectares of gypsiferous soils, 554 hectares (2.72 per cent) of the lands were gypsum mined and 19814 hectares (97.28 per cent) of lands were gypsum unmined. The extent of gypsum mined soils will increase further from this estimated figure as and when the mining activity is likely to combine in the unmined area especially in the physiographic unit U_1 (uplands with very gentle slope and low intensive cultivation). This kind of continuous process of degradation can be periodically monitored and damaged areas can be precisely estimated by employing satellite data. The same view was expressed by Moghe and Kalra (1988) and Saxena *et al.* (1991) for the continuous assessment of land degradation hazards through remote sensing techniques.

CONCLUSIONS

SPOT MLA FCC data on 1 : 50,000 scale were found to be useful in the recognition of different physiographic units in the study area. The recognition and identification of the physiographic units were made possible by the visual interpretation of the satellite imageries which depicted the different image interpretation elements such as tone, texture, size, pattern and association. Sufficient ground truth verification was found necessary for the identification of the soil and land use composition in each physiographic unit. SPOT data were useful in differentiating the mined and unmined soils and assessing their distribution and extent.

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